

WHAT IS CLAIMED IS:

1. A method for sculpting solids with sheet bodies in a computer-implemented solid modeling system, comprising:

5 (a) performing a selective Boolean operation on a part body and one or more sheet bodies, wherein faces of the sheet bodies separate the part body into regions of space such that the regions are separated from each other by the faces of the sheet bodies.

10 2. The method of claim 1, wherein the step of performing is invoked by a join option.

3. The method of claim 2, wherein the join specifies that material will be added to the part body.

15 4. The method of claim 1, wherein the step of performing is invoked by a cut option.

5. The method of claim 4, wherein the cut specifies material will be taken away from the part body.

20 6. The method of claim 1, wherein the sheet body has a face side label that indicates which side of the sheet should be used.

25 7. The method of claim 6, wherein the face side label is selected from a group comprising normal, anti-normal or both.

8. The method of claim 1, wherein the performing step (a) comprises:

(1) performing a pre-processing phase to create a cellular topology graph of tool and blank bodies created from the part body and the sheet bodies;

30 (2) performing an analysis phase to categorize and convert cells in the cellular topology graph; and

(3) performing a post-processing phase to integrate results from the analysis phase

to create an output part body.

9. The method of claim 1, wherein the performing step (a) comprises:
- (1) labeling faces in the part body and sheet bodies;
  - 5 (2) creating a blank body from the part body and the sheet bodies;
  - (3) creating a tool body large enough to contain the blank body in its entirety;
  - (4) applying a selective Boolean operation to the tool body and blank body to generate a collection of solid cells;
  - (5) generating a cellular topology graph that contains a vertex for each cell in the
  - 10 collection of solid cells, and graph edges between pairs of vertices whenever their associated cells in the collection of solid cells are adjacent;
  - (6) creating a meta-graph from the cellular topology graph and the part body;
  - (7) categorizing the meta-graph's cells as either interior cells or exterior cells;
  - (8) selectively converting the categorized cells from interior to exterior or exterior
  - 15 to interior; and
  - (9) combining the meta-graph's cells marked as interior to create an output part body.

10. The method of claim 9, wherein the labeling step (1) comprises marking
- 20 all faces in the part body with an attribute that identifies them as being part of the part body and marking all faces on the limiting sheets with an attribute that identifies them as being part of the sheet bodies.

11. The method of claim 9, wherein the creating step (2) comprises:
- 25 turning the part body into a hollowed-out part body in order to form a sheet body;
- and
- creating the blank body by uniting all the limiting sheets together with the hollowed-out part body to create a non-manifold sheet body.

- 30 12. The method of claim 9, wherein the selectively converting step (8) comprises:

converting all critical exterior cells to interior cells, if a join is performed.

13. The method of claim 9, wherein the selectively converting step (8) comprises:

5 converting all critical interior cells to exterior cells, if a cut is performed.

14. An apparatus for sculpting solids with sheet bodies, comprising:  
a computer; and

a solid modeling system, executed by the computer, having logic for:

10 (a) performing a selective Boolean operation on a part body and a sheet body, wherein faces of the sheet body separate the part body into regions of space such that the regions are separated from each other by the faces from the sheet body.

15 15. The apparatus of claim 14, wherein the logic for performing (a) is invoked by a join option.

16. The apparatus of claim 15, wherein the join specifies that material will be added to the part body.

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17. The apparatus of claim 14, wherein the logic for performing (a) is invoked by a cut option.

18. The apparatus of claim 17, wherein the cut specifies material will be taken  
25 away from the part body.

19. The apparatus of claim 14, wherein the sheet body has a face side label that indicates which side of the sheet should be used.

30 20. The apparatus of claim 19, wherein the face side label is selected from a group comprising normal, anti-normal or both.

21. The apparatus of claim 14, wherein the logic for performing (a) comprises logic for:

- (1) performing a pre-processing phase to create a cellular topology graph of tool  
5 and blank bodies created from the part body and the sheet bodies;
- (2) performing an analysis phase to categorize and convert cells in the cellular topology graph; and
- (3) performing a post-processing phase to integrate results from the analysis phase to create an output part body.

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22. The apparatus of claim 14, wherein the logic for performing (a) comprises logic for:

- (1) labeling faces in the part body and sheet bodies;
- (2) creating a blank body from the part body and the sheet bodies;
- 15 (3) creating a tool body large enough to contain the blank body in its entirety;
- (4) applying a selective Boolean operation to the tool body and blank body to generate a collection of solid cells;
- (5) generating a cellular topology graph that contains a vertex for each cell in the collection of solid cells, and graph edges between pairs of vertices whenever their  
20 associated cells in the collection of solid cells are adjacent;
- (6) creating a meta-graph from the cellular topology graph and the part body;
- (7) categorizing the meta-graph's cells as either interior cells or exterior cells;
- (8) selectively converting the categorized cells from interior to exterior or exterior to interior; and
- 25 (9) combining the meta-graph's cells marked as interior to create an output part body.

23. The apparatus of claim 22, wherein the logic for labeling (1) comprises logic for marking all faces in the part body with an attribute that identifies them as being  
30 part of the part body and marking all faces on the limiting sheets with an attribute that identifies them as being part of the sheet bodies.

24. The apparatus of claim 22, wherein the logic for creating (2) comprises logic for:

turning the part body into a hollowed-out part body in order to form a sheet body;

5 and

creating the blank body by uniting all the limiting sheets together with the hollowed-out part body to create a non-manifold sheet body.

25. The apparatus of claim 22, wherein the logic for selectively converting (8) comprises logic for:

converting all critical exterior cells to interior cells, if a join is performed.

26. The apparatus of claim 22, wherein the logic for selectively converting (8) comprises logic for:

15 converting all critical interior cells to exterior cells, if a cut is performed.

27. An article of manufacture embodying logic for sculpting solids with sheet bodies in a computer-implemented solid modeling system, the logic comprising:

(a) performing a selective Boolean operation on a part body and a sheet body, wherein faces of the sheet body separate the part body into regions of space such that the regions are separated from each other by the faces from the sheet body.

28. The article of claim 27, wherein the step of performing is invoked by a join option.

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29. The article of claim 28, wherein the join specifies that material will be added to the part body.

30. The article of claim 27, wherein the step of performing is invoked by a cut option.

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31. The article of claim 30, wherein the cut specifies material will be taken away from the part body.

32. The article of claim 27, wherein the sheet body has a face side label that  
5 indicates which side of the sheet should be used.

33. The article of claim 32, wherein the face side label is selected from a group comprising normal, anti-normal or both.

10 34. The article of claim 27, wherein the performing step (a) comprises:  
(1) performing a pre-processing phase to create a cellular topology graph of tool and blank bodies created from the part body and the sheet bodies;  
(2) performing an analysis phase to categorize and convert cells in the cellular topology graph; and  
15 (3) performing a post-processing phase to integrate results from the analysis phase to create an output part body.

35. The article of claim 27, wherein the performing step (a) comprises:  
(1) labeling faces in the part body and sheet bodies;  
20 (2) creating a blank body from the part body and the sheet bodies;  
(3) creating a tool body large enough to contain the blank body in its entirety;  
(4) applying a selective Boolean operation to the tool body and blank body to generate a collection of solid cells;  
(5) generating a cellular topology graph that contains a vertex for each cell in the  
25 collection of solid cells, and graph edges between pairs of vertices whenever their associated cells in the collection of solid cells are adjacent;  
(6) creating a meta-graph from the cellular topology graph and the part body;  
(7) categorizing the meta-graph's cells as either interior cells or exterior cells;  
(8) selectively converting the categorized cells from interior to exterior or exterior  
30 to interior; and

(9) combining the meta-graph's cells marked as interior to create an output part body.

5           36.     The article of claim 35, wherein the labeling step (1) comprises marking all faces in the part body with an attribute that identifies them as being part of the part body and marking all faces on the limiting sheets with an attribute that identifies them as being part of the sheet bodies.

10           37.     The article of claim 35, wherein the creating step (2) comprises:  
turning the part body into a hollowed-out part body in order to form a sheet body;  
and  
creating the blank body by uniting all the limiting sheets together with the hollowed-out part body to create a non-manifold sheet body.

15           38.     The article of claim 35, wherein the selectively converting step (8) comprises:  
converting all critical exterior cells to interior cells, if a join is performed.

20           39.     The article of claim 35, wherein the selectively converting step (8) comprises:  
converting all critical interior cells to exterior cells, if a cut is performed.